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**NATIONAL DEFENSE UNIVERSITY**

**NATIONAL WAR COLLEGE**

**Radioactive Waste in the Nordic and Far East Seas;  
a Soviet Legacy with International Environmental  
and National Security Repercussions**

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE <b>1994</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-1994 to 00-00-1994</b>	
4. TITLE AND SUBTITLE <b>Radioactive Waste in the Nordic and Far East Seas; a Soviet Legacy with International Environmental and National Security Repercussions</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>National War College, 300 5th Avenue, Fort Lesley J. McNair, Washington, DC, 20319-6000</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <b>see report</b>					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES <b>40</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

## INTRODUCTION

Between 1959 and 1991, the Soviet Union engaged in an aggressive initiative to design, develop, and deploy nuclear weapons and nuclear power programs in support of national security objectives. The focused, single-minded approach of the Soviet's nuclear effort, and the urgency of their developments rejected any considerations of cost: financial, human, or environmental. As a result, radioactive waste management received virtually no attention, and nuclear waste disposal was conducted in a criminally negligent fashion.

Deliberate dumping of numerous Soviet civilian and military nuclear reactors, principally by the Northern and Pacific Fleet Submarine Force, into the Northern and Far East Seas; radioactive waste leak-off from Russian nuclear reactors like those at Silamae and Paldiski, Estonia into the Baltic Sea; and liquid/solid radioactive waste dumping into several of the world's oceans have created an environmental legacy which will affect all nations who use those waters for industry, commerce, transportation, and recreation. Despite: a growing body of evidence that unimpeded radioactive waste dumping is ecologically unsafe; the existence of several prohibitory international treaties to which the USSR/Russian Federation has agreed; and an expanding list of nuclear reactor accidents; the Russian Federation has elected to continue operating the nuclear power program inherited from the Soviet Union in a "business as usual" manner. Continued Russian radioactive waste dumping at sea will provoke regional tensions amongst the Arctic countries, exacerbate tenant/landlord relationships and fears within the former Soviet Republics in the Baltics, and force aggressive Japanese economic, aid, and defense counter-action in the Far East.

The legal framework for dealing with the issue of national and international responsibility and liability relating to radioactive waste disposal has been evolutionary and non-coercive. The financial resources available to governments for environmental clean-up are severely limited. Is the fouling of the global commons going to be tolerated as a natural by-product of the Cold War? Should there be any expectation of improved environmental actions by the Russian Federation? If

the former Soviet Union's radioactive waste dumps could directly hazard the health of U.S. citizens, cause species extinction of local maritime species, spread contamination across ocean areas decreasing fishing stocks, and alter indigenous peoples subsistence lifestyle and culture, would or should that stimulate a U.S. foreign policy response?.

A clear understanding of the sources of Soviet and Russian radioactive pollution, the context of the international legal framework on nuclear waste dumping, and the scientific assessments of the ecological impacts discovered to date, will allow us to determine which U.S. interests might be threatened, and what policy initiatives might be pursued to resolve the issue of Russian nuclear waste dumping at sea.

### **SOURCES OF SOVIET ERA RADIOACTIVE OCEANIC POLLUTION**

Radioactivity equivalent to roughly half the fall-out from Chernobyl was dumped or lost at sea by the Former Soviet Union (FSU) between 1959 and 1991, according to a 1993 statement by the Russian Environment Minister, Viktor Danilov-Danilyan<sup>1</sup>. The radioactive contamination came from both military and civilian liquid and solid nuclear waste disposal, reactor core dumping, marine accidents, and ground run-off from nuclear power plants and shipyards ashore. The dumping was deliberate, hidden from the Soviet as well as the international public, and carelessly executed; in the words of then CIA Director Gates: "The Former Soviet Union's attitude toward safety in handling radioactive waste was lackadaisical from the very beginning of its nuclear program."<sup>2</sup> A total of 2.5 million curies of radioactive waste was disposed during this period. This represents twice the combined total of twelve other nuclear nation's waste disposal.<sup>3</sup> The seas were selected as the depository of choice because it was far cheaper than building nuclear waste disposal plants.<sup>4</sup> A review of the locations and types of dumping indicate the severity of the problem by region.

### **NORTHERN SEAS**

Radioactive material dumped in the Kara and Barents Seas by the FSU included 17 nuclear submarine and icebreaker reactors, seven of which contained spent nuclear fuel which was not unloaded (and which pose the greatest ecological hazards) prior to disposal.<sup>5</sup> 17,000 barrels of

solid radioactive waste were sunk in the waters around Novaya Zemlya<sup>6</sup>, and 190,000 cubic meters of liquid waste were dumped in the Barents in five locations.<sup>7</sup> Open air nuclear waste storage facilities at Oleyna Guba, Sayda Guba, Ara Guba, and Pala Guba each contributed waste water leak-off and discharges into the Kola Fjord leading to the Barents Sea. Submarine decommissioning sites, shipyard facilities, and floating temporary storage sites at Polyarny, Yokanga, Murmansk, and Severodinsk also discharged solid and liquid waste into the Barents, via the Kola Fjord.<sup>8</sup> The Nuclear Weapons Production site at Krasnoyarsk-45 dumped its waste into the Yenisey River. Its effluent terminates in the Arctic Ocean.<sup>9</sup>

The FSU's Northern Fleet recorded at least 27 nuclear submarine accidents between 1961 and 1991, which created varying levels of nuclear pollution in the Atlantic Ocean, White Sea, Norwegian Sea, Arctic Ocean, and the Barents.<sup>10</sup> At least five of the submarines involved in accidents sank with full weapons loads and operating reactors. KOMSOMOLETS, a "Mike" class nuclear submarine which sank in 1700 meters of water south of Bear Island on 7 April 1989, became the media star in this hit parade of sunken Soviet subs. In addition to the reactor leakage of caesium and strontium, concern over the plutonium in two of KOMSOMOLETS nuclear tipped torpedoes has sparked lively scientific debate and international public arousal.<sup>11</sup> A potentially more devastating submarine loss occurred in October 1986 with the sinking of a "Yankee" class ballistic missile submarine (SSBN) 500 miles east of Bermuda. Two reactors, two plutonium torpedoes, and 16 submarine launched ballistic missiles (SLBMs) containing two warheads each remain with the sub's carcass at the ocean's floor.<sup>12</sup>

## **BALTIC SEA**

Radioactive contamination in the Baltic Sea and Gulf of Finland appear to have originated primarily with waste water disposal, leak-off from coastal nuclear reactors and shore-based radioactive waste dumps. One major FSU radioactive waste dump is located at Silamae, Estonia. With its more than four million tons of uranium waste exposed to the elements, the radioactive rainwater leak-off into the Gulf of Finland has been a long term contributor to Baltic nuclear pollution.<sup>13</sup> Two submarine training reactors in Paldiski, Estonia; four submarine test reactors at

Sosnovy Bor, Russia; one civilian research reactor at Salaspils, Latvia; four Light Water Graphite Moderated Reactors (RBMK-1000s) at the Leningradskaya civilian power plant (Sosnovy Bor); and the Ignalia, Lithuania civilian nuclear power plant all suffered from severe safety problems, and piled up their wastes in open areas, again leading to Baltic run-off.<sup>14</sup>

Twenty-three lighthouses along the Estonian coast are powered by strontium-90 sources; these badly corroded and neglected facilities have leached waste into the Baltic for several years.<sup>15</sup> Additionally, an unconfirmed report by German intelligence services indicates two FSU nuclear submarines were scuttled in the Baltic; if true, this could create similar hazards to the "Mike" and "Yankee" submarines previously discussed.<sup>16</sup>

The total FSU radioactive waste disposed in the Baltic is insignificant in comparison to the Barents/Kara Seas area; however, the closed nature of the Baltic Sea catchment poses special considerations for environmental cleanup.<sup>17</sup>

#### **SEA OF JAPAN/SEA OF OKHOTSK (SOJ/SOO)**

The FSU dumped at least 12,335 curies of liquid radioactive waste in five areas of the SOJ/SOO between 1966 and 1991. Solid radioactive waste dumping included over 6868 containers, 38 ships, and two submarine nuclear reactors, (spent fuel off-loaded), with peak dumping occurring in 1986-1987.<sup>18</sup> As in the Northern and Baltic Fleet areas, radioactive waste run-off from a nuclear waste site on the Kamchatka Peninsula contributed to the pollution totals.<sup>19</sup>

Fewer Soviet Pacific Fleet nuclear submarine accidents have been reported than in the Northern Fleet. However, these lesser numbers do not indicate a greater awareness by the Soviet Pacific Fleet for nuclear safety considerations, better ship material condition, improved repair capability, or radioactive waste handling consciousness. Quite the contrary. The most spectacular naval nuclear accident in the Soviet Navy occurred on August 10, 1985 at Chazma Bay (Vladivostok). During completion of reactor fueling work onboard a "Victor" class nuclear submarine, an uncontrolled spontaneous uranium fission chain reaction in the port reactor caused an explosion, resulting in a fire which killed 10 men and spilled nuclear fuel directly into the bay. Contamination spread in a 6 kilometer by 500 meter trail engulfing surrounding submarines, piers,

shipyard production facilities, and into Konyushkovo, Abrek, and Razboynik Bays. A total of 500,000 curies of radioactive substance was released into the surrounding air and water.<sup>20</sup> To facilitate the post clean up effort and resume work, three pits were dug in the hills behind Shkotovo-22 Ship Repair Facility *family housing* center, and the wreckage of the submarine's reactor and forward compartment were buried there.

The expanse of open ocean in the vicinity of the Far East dumping sites has contributed significantly to the dilution of nuclear waste, and has lessened the ecological impact of twenty-five years of FSU abuse. Relative to the Northern and Baltic Regions, the Far East Seas rank second in total radiation received.

### **SOURCES OF POST SOVIET RADIOACTIVE POLLUTION**

The magnitude of the FSU's radioactive waste dumping in the 33 years of Soviet nuclear program is staggering, until one considers what the Russian Federation faces in the years ahead. Russia currently owns 235 ships with nuclear propulsion plants: 228 military with a total of 394 reactors; and 7 civilian icebreakers with a total of 13 reactors. Annual operations of the military and civilian fleet generate 20,000 cubic meters of liquid radioactive waste, and 6,000 tons of solid waste. In compliance with START II, and in recognition of the material condition of the Russian Federation ships, by the year 2000 more than 150 nuclear submarines will have to be scrapped. Currently, 93 are in mothball status awaiting final disposition.<sup>21</sup>

Operation of the civilian nuclear power plants on the Kola Peninsula, in the Gulf of Finland, and Russian Far East coast (more than twenty of which were declared inherently unsafe and too dangerous to operate by the International Atomic Energy Agency {IAEA}<sup>22</sup>) will continue until an alternative electrical power source becomes available. These plants will generate their own waste, and continue the process of pollution run-off previously described.

Facilities for nuclear waste disposal were not constructed in 1972 or 1985 in the FSU, as originally planned by the FSU's Ministry of Atomic Energy. Without these facilities the Russian Navy has run out of places to store both liquid and solid radioactive waste. According to Admiral Viktor Topilin, Chief of the Navy Department of Operation and Repair, "Our storage facilities -

two in the North and two in the Far East - are practically 100 percent full, and there is nowhere else to put the spent fuel."<sup>23</sup> In fact, in 1992, the Russians dumped 3,000 metric tons of liquid waste in the Arctic, and an additional 3,000 metric tons in the Far East,<sup>24</sup> including the sinking of a tanker containing solid radioactive waste in the Sea of Japan.<sup>25</sup> On 17 October 1993, the Russians dumped 900 tons of liquid waste in the Sea of Japan.<sup>26</sup> Receiving more public scrutiny and international opprobrium than they ever dreamed of, the Russians cancelled a second disposal of 800 tons two days later.

At present, the Russian Federation is considering a program entitled "Russian Government Program for Handling, Recycling and Disposal of Radioactive Wastes and Spent Nuclear Materials for the 1993-1995 Period and Through 2005". Highlights of this program include construction of temporary storage sites for floating nuclear submarines; retrofitting of shelters for temporary storage of reactor compartments; temporary storage facilities for liquid and solid nuclear waste, and capacity for disposal of high level solid radioactive waste *at the earliest* in 1997.<sup>27</sup> Russia's bottom line is best summed up by Environmental Minister Viktor Danilov-Danilyan: "While Russia supports the idea of a total legal prohibition, it lacks the money and technical expertise to build enough land-based storage sites for its low level wastes and will probably have to resume ocean dumping of these materials by 1995."<sup>28</sup>

We have examined the record on Soviet era pollution, and followed the marginally successful transition of the FSU's nuclear power program to the Russian Federation. What has been missing from this dialog is the legal context under which the USSR/Russian Federation has made its decisions on radioactive waste dumping. Were these results, unsavory though they are from an ecological perspective, legal in either the international or national arenas?



## INTERNATIONAL LAW ON RADIOACTIVE WASTE POLLUTION AT SEA

International action to control the disposal of radioactive wastes at sea began in the 1950s with the United Nations Conventions on the Law of the Sea (UNCLOS I). Specifically, the Geneva Convention on the High Seas, 1958 stipulates in Article 25(2) for states "to cooperate with competent international organizations in taking measures" to prevent pollution of the seas or airspace above resulting from "activities with radioactive materials or other harmful agents."<sup>29</sup> No penalties are arrayed for violators, but for the first time, the international community was on record concerning radioactive waste disposal. Ironically, this passage was inserted by the Soviet Government as an attempt to slow down the United States' nuclear testing program, and served as a precursor to the 1963 Limited Nuclear Test Ban Treaty.<sup>30</sup> The USSR ratified this convention on 22 November 1960; UNCLOS I came into force 30 September 1962.<sup>31</sup>

UNCLOS I was followed by a more thorough treatment of radioactive waste pollution in the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (more commonly referred to as the London Dumping Convention). In Article III (a) 1, dumping is defined as "any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms, or other man made structures at sea".<sup>32</sup> Wastes are divided into three categories: the "Black List", which includes high level radioactive wastes as defined by the IAEA (listed separately in Annex I of the Convention);<sup>33</sup> the "Grey List" which includes intermediate level radioactive wastes not included in Annex 1 (listed separately in Annex 2);<sup>34</sup> and third, all other wastes not on the Black or Grey lists (no separate annex listing). Article IV prohibits dumping of any Black list material, mandates a prior special permit before dumping of Grey List material, and requires a prior general permit for all others.

All parties to the London Dumping Convention have agreed, by Article VII, to take legislative action to implement the dumping agreements. Article VII further stipulates that the Convention does not apply to those vessels and aircraft entitled to sovereign immunity under international law (including warships), but *irregardless of originating source* (sovereign/non-sovereign), any radioactive waste dumping must be reported. Additionally, all parties to the

Convention are required by Article VI (1) c to "keep records of the nature and quantities of all matter permitted to be dumped, and the location, time, and method of dumping"<sup>35</sup> to be reported to the Intergovernmental Marine Consultative Organization (IMCO). The weakness of the London Dumping Convention comes in Article X, where enforcement is not rigorously spelled out: "In accordance with the principles of international law regarding state responsibility for damage to the environment...parties undertake to develop procedures for the assessment of liability and the settlement of disputes regarding dumping."<sup>36</sup> The USSR ratified the London Dumping Convention on December 30, 1975; date of entry into force was January 29, 1976.

A regional convention enacted during this period took a much stricter approach to dumping than the London Dumping Convention. Article 9 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention), 1974 prohibits all dumping; however it too lacks enforcement powers.<sup>37</sup> Denmark, Finland, German Democratic Republic, Federal Republic of Germany, Poland, Sweden, and the USSR signed the Convention on March 22, 1974, and it was entered into force on 3 May 1980.<sup>38</sup>

A comprehensive regime for the law of the sea was established in the United Nations Convention on the Law of the Sea, 1982 (UNCLOS III). The Convention provides a framework for the regulation of all ocean space, which has many influences on the legal issues surrounding radioactive waste dumping at sea. Responding to the United Nations General Assembly Declaration of Principles (Resolution 2749 (XXV)), the Convention defines the sea-bed and ocean floor beyond the limits of national jurisdiction as the common heritage of mankind (Article 136). It continues by stating that "all rights in the Area's resources were vested in mankind as a whole, on whose behalf the Authority was to act" (Article 137); liability is established for damages caused by failure to carry out a State's responsibility (Article 139); and regulations for the control of pollution and other environmental hazards are outlined in Article 145.<sup>39</sup> The Convention creates a new institution to deal with disputes that stem from issues raised in Articles 136 to 145; the International Tribunal for the Law of the Sea.<sup>40</sup> Its powers are focused principally towards

exploitation of deep sea mineral resources; however it may become a useful forum for settlement of pollution disputes.

UNCLOS III's provisions on pollution by dumping are generally consistent with the London Dumping Convention, 1972. Articles 210 (5,6) and 216 give a coastal state the right to make and enforce regulations to control dumping at sea at least as stringent as the global rules and standards. Article 192 gives all states the obligation to protect and preserve the marine environment; Article 194 outlines the measures to prevent, reduce and control pollution of the marine environment including "the release of toxic, harmful, or noxious substances, especially those which are persistent, from land based sources, from or through the atmosphere or by dumping."<sup>41</sup> Article 207 addresses pollution from land based sources into the marine environment (for example, radioactive waste drain-off from a nuclear power plant into a river contiguous to the sea), and is consistent with the wording of Article 194, and the precepts of Article 210. Finally, Article 235 articulates the responsibilities and liabilities of states; to include: "States shall cooperate in the implementation of existing international law relating to responsibility and liability for the assessment of and compensation for damage and the settlement of related disputes."<sup>42</sup> The USSR signed the Final Act and the Convention on 10 December 1982.<sup>43</sup>

UNCLOS III has many other provisions which bear directly or indirectly on the prevention of pollution in general, and the rights and responsibilities that coastal states must adhere to in order to maintain a viable economic exclusion zone and secure coastal waters. In the interest of brevity, these provisions will not be specifically addressed.

Provisions of the London Dumping Convention were revisited in 1983, when the parties to the Convention adopted a voluntary moratorium on radioactive waste dumping for two years. An environmental assessment of known radioactive waste dump sites was conducted; its inconclusive findings in 1985 prompted a continuation of the voluntary moratorium, from which the USSR abstained.<sup>44</sup>

In September 1989, representatives of the United States, Canada, USSR, Denmark, Iceland, Finland, Norway, and Sweden met in Rovaniemi, Finland to address the "Finnish

Initiative", an Arctic Environment Protection Strategy designed to combat the deterioration of the fragile Arctic ecosystem. Among the six agenda items was a detailed consideration of radioactive waste in the Arctic, principally generated by Soviet Military practices. After two years of concentrated effort, the "Rovaniemi Strategy" adopted a joint action plan which includes: cooperation in scientific research to specify sources, pathways, sinks, and effects of radioactive pollution; an assessment of potential environmental impacts; and implementation and consideration of further measures to control pollutants. Key to this convention is the Arctic Monitoring and Assessment Program (AMAP), conducted by the Arctic Monitoring and Assessment Task Force. The convention is voluntary and dependent on the cooperative efforts of all parties; no sanction mechanisms are resident in the declaration. All eight states signed the Declaration on the Protection of the Arctic Environment and placed it in force on 14 June 1991.<sup>45</sup>

The Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) 1974 was revised by all signatories on April 9, 1992. Significant changes to this regional convention include: treating internal waters (through which land-based pollution reaches the Baltic) as an area under the Helsinki Convention's jurisdiction;<sup>46</sup> adoption of the "polluter pays" principle with realistic user charges (Article 3{4});<sup>47</sup> emphasizing information exchange (Article 16(1-2)); and broadening participation amongst Baltic countries adding: the Czech and Slovak republics, Norway, Ukraine, Estonia, Latvia, and Lithuania. The prohibition on dumping (Article 9) remains in effect; however it remains to be seen how effectively "polluter pays" is enforced.

In June 1992, the UN Conference on Environment and Development (UNCED) completed agreement on the non-binding Agenda 21 and issued the Rio Declaration on Environment and Development. As a call to action, UNCED's Agenda 21 could be viewed as a revival of commitment on complex global environmental challenges. As a means of achieving specific, binding agreements with enforceable statutes, "Agenda 21 does not break much new ground in the assault on sea-based pollution."<sup>48</sup> The UNCED Oceans agenda calls for "Protection of oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas, and the protection,

rational use and development of their living resources."<sup>49</sup> Chapter 17 of Agenda 21 highlights marine environmental protection, broken down into land based activities, and sea based activities, including dumping.<sup>50</sup> The Agenda states that "Appropriate steps to stop ocean dumping and the open ocean incineration of hazardous substances should be taken."<sup>51</sup> Agenda 21 recommends establishment of a global data base on marine pollution, to serve as a clearing house for information and technology exchanges. More significantly, the Agenda calls for replacement of the voluntary London Dumping Convention's 1985 moratorium on radioactive waste dumping with a total ban.<sup>52</sup> Additionally, Agenda 21 promotes: "The storage or disposal of high-level, intermediate level and low-level radioactive wastes should be prohibited near the marine environment unless scientific evidence shows that such storage or disposal poses no unacceptable risk to people or the marine environment or does not interfere with other legitimate uses of the sea."<sup>53</sup> UNCED's Agenda 21 has kept the focus on radioactive waste disposal at sea, but it should not be viewed as anything more than an interim step in the search for binding international statutes.

Since the London Dumping Convention took effect in 1972, sixteen consultative conferences of representatives of the signatories have been held, the most recent being November 8-12, 1993. The principal topic at the latest conference was a proposal, formally extended by Denmark in July 1993, to completely ban radioactive waste dumping at sea.<sup>54</sup> Prior to the 16th consultative conference, Russia, Japan and the United States all endorsed the ban.<sup>55</sup> On 12 November 1993, a permanent ban was approved by 42 of the 71 nations that originally signed the 1972 convention. Russia, Britain, France, China, and Belgium abstained (and hence are not legally bound by the total ban). Provisions for enforcement have not been outlined to date.<sup>56</sup> Following Russia's abstention, increasing international diplomatic pressure was applied to force her to comply. Russia's rebuttal is that there is neither money nor technical expertise to build adequate land based storage sites, and thus the only near term alternative is to continue dumping. While the political ramifications of that statement are under diplomatic review, the United States, along with the other signatories, has agreed to form a team to assess Russia's storage requirements.<sup>57</sup>

It is clear from the international legal audit trail above (UNCLOS I, London Dumping Convention, 1972, Helsinki Convention 1974, UNCLOS III, Finnish Initiative 1991, Helsinki Convention 1992, and UNCED's Agenda 21, 1992) that both the Soviet Union and Russian Federation committed themselves to cease radioactive waste dumping at sea. Equally clear is the lack of hard nosed legal remedies to prevent or make prohibitively expensive the continued dumping of radioactive waste despite the international communities interest in arresting this problem. Each of the conventions above required individual state legislative action. A review of USSR/Russian Federation regulations will round out the consideration of the legal aspects of Russia's environmental legacy.

### **USSR/RUSSIAN FEDERATION LAW ON RADIOACTIVE WASTE POLLUTION AT SEA**

In response to the requirements of UNCLOS I, 1958, the Soviet Navy, Ministry of Medium Machine Building, and the Third Main Administration of the USSR Ministry of Public Health crafted the 1960 "Temporary Sanitary Requirements for Discharge of Liquid Wastes Containing Long-Lived Radioactive Substances into the Sea From Naval Facilities". This law was updated in 1962 and 1965 by the Soviet Navy, increasing the specificity of handling requirements of liquid radioactive waste, permitting the dumping of liquid radioactive waste outside of 10 nautical miles from land, and allowing dumping of solid radioactive waste in unshielded metal containers. In 1966, a completely revised regulation: "Temporary Sanitary Requirements for Disposal of Radioactive Wastes at Sea" (VSTZ-66) was put into effect by the Soviet Navy and the USSR Ministry of Public Health. It stipulated additional requirements for radioactive waste discharge and disposal areas, radiation hygiene monitoring at disposal sites, and transportation/handling restrictions.<sup>58</sup> The 1960, 1962, 1965 and 1966 laws ensured that on paper the USSR was in compliance with its international obligations under UNCLOS I.

Following the signing of the 1972 London Dumping Convention, the USSR Council of Ministers on 6 March 1979, adopted Resolution 222, "Measures To Ensure Performance Of the Soviet Side's Obligations Following From the 1972 Convention On the Prevention of Pollution of

the Sea By Discharges of Wastes". This Soviet regulation prohibited intentional dumping of high level radioactive waste (consistent with the LDC Black list), required permits for dumping of intermediate level waste from the USSR State Committee For Hydrometeorology (consistent with the LDC Grey list) and followed the recording of characteristics, quantity, size, time, method, of dumping and notification procedures verbatim from the International Convention. The Soviet Navy implemented Resolution 222 through "Regulations For Discharge of Radioactive Waste at Sea (PS-82)" in 1983.<sup>59</sup> The Soviet legislative effort was faithful to the terms of the London Convention; however there was a *seven year delay* from the Convention in force date (29 January 1976) to the execution of PS-82.

In the Russian Federation White Paper, Facts and Problems Related to Radioactive Waste Disposal in Seas Adjacent to the Territory of the Russian Federation, also known as the Yablokov Report, the President of the Russian Federation acknowledged that actual Soviet radioactive waste management was neither in accordance with international nor USSR statute: "The USSR performed the majority of its radioactive waste dumping at sea between 1959 and 1976, i.e., before the London Convention applied to the USSR. After signing the Convention, it violated the requirements including its own PS-82, conciously and frequently."<sup>60</sup>

Violations included: dumping of material on the LDC Black list, lack of reporting to the IMCO and IAEA of radioactive waste disposal of the Soviet Navy; and outright lying to the London Dumping Convention 1989 IAEA Circular Questionnaire. The Soviet's blatant response was: "The USSR has not dumped, is not dumping, and does not plan to dump radioactive waste at sea."<sup>61</sup>

Additionally, an interagency dispute between the State Committee for Hydrometeorology and the Soviet Navy over the development of radioactive waste handling facilities in 1986 caused withdrawal of Soviet State approval for PS-82 on 1 December 1987. After that time, the Soviet Navy approved its own radioactive waste dumping requests, without supervision from the State.<sup>62</sup>

Following the demise of the USSR, the Russian Federation passed "The Protection of the Natural Environment Law" (December 1991), which stipulates in "Ecological Requirements in the

Use of Radioactive Materials" (Article 50): "The import of radioactive waste and materials from other nations for storage or disposal purposes, and the sinking or sending into space of radioactive waste and materials for disposal purposes is prohibited."<sup>63</sup> This law is consistent with the Russians supportive position of UNCED's Agenda 21, the 1992 Helsinki Convention, and the London Dumping Convention. Legislative support and endorsement of international conventions of course does not translate into compliance with international regulation, as the 17 October 1993 Russian dumping incident in the Sea of Japan indicated.<sup>64</sup>

### **ASSESSMENT OF RADIOACTIVE WASTE DANGER TO MARINE ECOLOGY**

Murray Feshbach, author of Ecocide in the USSR paints a stark picture of the environmental impacts imposed by the Soviet's system of industrialization, militarization, and waste management: "When historians finally conduct an autopsy on the Soviet Union and Soviet Communism, they may reach the verdict of death by ecocide."<sup>65</sup> Others describe the Russian situation in even more apocalyptic terms: "Untrammelled power and conceit have produced an ecological and human disaster of biblical proportions. The consequences will have to be endured for generations to come."<sup>66</sup>

But emotionalism and anxiety over the residue from the nuclear genie aside, what scientific evidence exists to suggest that Soviet/Russian radioactive waste dumping at sea has caused or will impose ecological degradations in the Barents, Kara, White, Baltic Seas, Arctic Ocean, Sea of Japan and Sea of Okhotsk? Can it be said that radioactive contamination in the shallow sea where the marine food chain begins could contaminate the fishing stocks of cod, haddock, Atlantic and Pacific salmon? If so, this would produce an economic disaster for Norwegian, Russian, and Japanese fish exporting industries.<sup>67</sup> Is it true that 95 per cent of the children in the Arkhangelsk Oblast have been born with congenital debilities, cancers, and blood diseases due to the radioactive pollution in the White and Barents Seas, as reported by the Arkhangelsk Medical Institute?<sup>68</sup>

Results of a joint Norwegian/Russian radioactive study of the Barents and Kara Seas, conducted in the summer of 1992 suggest not. Sampling of seawater, sea floor deposits, and seaweed reveal that the content of caesium-137 radionuclides did not exceed their natural levels.<sup>69</sup>



However, researchers were not allowed to get closer than 30 miles to the dump site. In contrast, physical evidence of massive deaths of starfish in the White Sea in 1990,<sup>70</sup> and whales and seals in 1992,<sup>71</sup> provided indication that an unusual phenomena was at work.

Richard Guimond, Deputy Assistant Administrator, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, in 1992 Congressional testimony reported that transport and uptake of radioactive contaminants in the food chain was dependent on the specific radionucleides. Plutonium adheres to the ocean sediment, and is only accessible to benthic marine organisms; strontium-90 is highly mobile, and would be available to plankton and salmon. Radionucleides are subject to the ocean dilution factor and natural decay over their half life as well.<sup>72</sup> Circulation patterns of surface water and ice pack in the Arctic would tend to push mobile pollutants towards Greenland and Canada; narrow, swift moving deep ocean currents would allow contaminants such as strontium-90 to be moved relatively long distances, according to Dr. Stephanie L. Pfirman of the Environmental Defense Fund.<sup>73</sup>

In June 1993, 116 international scientists gathered at the Woods Hole Oceanographic Institution to analyze the ecological impact of the Yablokov report. In their collective opinion: "There is strong consensus among conference participants that there is no evidence of any regional scale radioactive contamination in the Arctic and North Atlantic Oceans that currently poses a threat to human health or causes environmental concern."<sup>74</sup> Charles Hollister, an oceanographer at Woods Hole, suggests that the sampling procedure to date may have been "a little crude"; and that Russian scientists' dire predictions might be a subtle ploy to acquire Western funds. However, all scientists present agreed that better monitoring of all waste sites is mandatory for an accurate assessment and prediction of ecological impact.<sup>75</sup>

A similar conference was held in August 1993 in Kirkenes, Norway with 130 international scientists. Results of this conference did not contradict the efforts at Woods Hole; however, increasing impatience by the Western environmental community was expressed due to the repeated refusal of the Russians to allow some dump sites to be sampled. Both the KOMSOMOLETS (Norwegian Sea accident 1989), and the radioactive waste runoff from Chelabynsk into the Ob

River and Kara Sea highlighted the concerns of the Kirkenes Convention. Consensus opinion concluded that doubts as to the accuracy of ecological assessments would remain as long as the Russians refuse to allow access to all their dumping sites.<sup>76</sup>

In response to U.S. Senate Report 102-408 and the requirement in Public Law 102-396, Section 9110(b){1}, the Office of Naval Research conducted a \$10 million study of nuclear waste disposal by the Former Soviet Union in the Arctic Region. The primary objective of this 1993 study was to determine with high confidence whether or not there was a threat to the Alaskan economy or the health of U.S. citizens from radioactive waste dumping. Their tentative conclusions indicate there is no imminent threat to Alaskan waters: a) no experimental evidence that significant radiation has escaped from the reactors or containers in the Kara Sea; b) sampling in the Western Arctic near Alaska show low radiation levels; c) even if all the radiation dumped were in soluble form at the time of dumping, the additional radioactivity near Alaska would be less than background levels for Alaskan waters.<sup>77</sup> An additional eighteen months of research remains under the FY 93 funding; projects planned include sampling off the Kamchatka Peninsula and the Western Aleutians. The final assessment will be provided to the Congress in FY 95.

Mixed evidence, reluctance on the part of the Russians to come completely clean, and suspected motives make assessment of the ecological dangers of Russian radioactive waste dumping difficult to come to grips with. In the short term, it would appear that the Norwegian, Japanese, and Alaskan fisheries industry will remain unthreatened, and ecological damage will remain principally with its creators: the Russians.

### **U.S. INTERESTS**

The disclosures of the Former Soviet Union's egregious environmental abuse of the Arctic, Baltic, and Far East Seas contained in the 1993 Yablokov Report reveal a level of ecological illiteracy that is frightening. The report also indicates a willingness on the part of the USSR, over a lengthy period of time, to violate international and national law and conceal conduct outside the international norm. The execution of radioactive waste dumping in October 1993 demonstrated that the Russian Federation has not yet committed to short term resolution of its nuclear waste

management problems, and unless closely monitored, will continue to operate in the same old "business as usual" fashion. Obfuscation will be the rule rather than the exception on nuclear waste disposal. In my opinion, this raises questions about the effectiveness of international institutions, the degree of political and institutional change in the newly democratizing Russia, and the reliability of Russian commitments to treaty obligation - be they London Dumping Convention, START II, or Cooperative Threat Reduction.

What U.S. interests are at stake in achieving cessation of Russia's nuclear waste disposal at sea? What would cause the U.S. to appropriate resources or to expend political capital to redress this issue? I would suggest there are three U.S. national interests directly involved in this issue: survival, promoting regional stability, and confronting global challenges in the form of reducing environmental dangers.

Ensuring that the health of the American people, particularly those in Alaska, is not endangered by continued reckless dumping of waste in the Arctic seas, and by unsafe operation of Russian military and civilian nuclear reactors is the principle responsibility of the U.S. Government, and is fundamentally a survival interest. The Arctic is the principal food source for Alaskans; monitoring mechanisms must be put in place to warn if and when transported radionuclides enter the food chain in concentrations greater than background levels.<sup>78</sup> Additionally, Russian Navy and civilian nuclear reactor safety deficiencies must not be allowed to create additional Chazma Bay accidents with potential high levels of radioactivity released into the air and oceans.

Second, regional stability is threatened by FSU pollution practices and by continued Russian disposal of radioactive waste in the Arctic, Baltic, and Far East Seas. In the North, the economies of Norway, Iceland, and Canada are very dependent on the viability of the Arctic biomass. In Iceland, the fishery industry supplies over 70 per cent of Iceland's exported goods, and generates more than 50 per cent of their total export revenue.<sup>79</sup> The Norwegians have been very vocal in their view of the threat. Norway's Defense Minister, Johan Jorgen Holst, in an April 1992 interview stated: "If the rumor gets around that Norwegian and Russian fish are contaminated with

radioactivity, we aren't going to sell many fish."<sup>80</sup> Species extinction, decrease of fishing stocks, and marketability of catch could become such a threat to Northern fisheries that aggressive and destabilizing fleet interactions (similar to the Cod Wars of the 1970s) would ensue.

In the Baltic, the partial withdrawal of Russian troops from Estonia has revealed the magnitude of the disastrous environmental legacy left behind. As a result, Estonia is likely to call for compensation from Russia to clean up the nuclear waste dump at Silamae. Additionally, the timetable for dismantlement of two submarine training reactors at Paldiski, still under Russian control, remains a matter of significant contention between the Estonians and the Russians. The Russian authorities have stated that they will be unable to complete the decommissioning of the two reactors until 1998, yet final troop withdrawal is scheduled for 31 August 1994.<sup>81</sup> The Russian overbearing presence in their "near abroad" neighbor's backyard has not been ameliorated by their actions in Silamae and Paldiski. Promoting regional stability in the Baltics will require resolution of Russia's radioactive waste dilemma.

The Far East has been the most dynamic, and destabilized region within the context of Russian radioactive waste management. The Japanese insisted on making oceanic nuclear waste dumping a subject for discussion at the April 1993 G-7 Tokyo Summit. The Final Report highlighted the issue as a matter of "great concern" and called for Russia to stop dumping spent reactors and other nuclear components in the ocean.<sup>82</sup> In follow on bilateral talks, the Japanese promised \$100 million for aid in disposing of nuclear wastes to the Russian Federation, if they would comply.<sup>83</sup>

On 11-13 October 1993, President Yeltsin and Prime Minister Hosokawa conducted a bilateral summit, which resulted in several new agreements pledging increased cooperation and friendship. The leaders specifically agreed to jointly study ocean dumping as a summit agenda item.<sup>84</sup> However, only three days after Yeltsin left Tokyo, Russian Naval Tanker TNT-27 dumped 900 tons of liquid radioactive waste 190 kilometers southeast of Vladivostok in the Sea of Japan.<sup>85</sup> The resulting Japanese outrage was best captured by IZVESTIA's Tokyo correspondent: "A new discharge of Russian radioactive waste into the Sea of Japan threatens to cancel out the results of

Yeltsin's visit to Japan. What has happened is a heavy blow for bilateral relations...the Russian side, as it is viewed from Japan, has spat on the agreements and once again demonstrated that Moscow's calls for new, trustworthy relations remain empty calls."<sup>86</sup>

On October 19, Vice Foreign Minister Saito was forced to reprimand Russian Ambassador Chizhov for a contemplated second dumping of 800 tons of liquid waste.<sup>87</sup> In view of the uproar over the incident, the Russian's elected not to conduct the second dumping, and sent the ship back to Vladivostok.<sup>88</sup> Accordingly, on December 15, 1993, a joint Russian Japanese Mission held talks to discuss construction of a radioactive waste disposal facility as a portion of the promised \$100 million in aid.<sup>89</sup>

If Russia persists in thumbing their nose at the Japanese by continuing to dump nuclear wastes, it is conceivable that not only will the \$100 million in aid be restricted or withdrawn, but that Japanese Maritime Self Defense Force units would seek to block future dumping events. This would be most disruptive to Far East regional security, and could potentially interpose the U.S. Seventh Fleet between angry neighbors as a stabilizing influence.

Finally, in the Russian Federation itself, improvement on the radioactive waste management issue could go far towards satisfying a growing minority of environmentally dissatisfied citizens. In the past five years, a Russian anti-nuclear movement in the Far East area conducted several disruptive practices which included: protesting the military's handling of the Chazma Bay cleanup; opposing decommissioning/dismantlement of nuclear submarines in the Sovetskaya Gavan area; preventing the docking of the nuclear powered merchant ship SEVMORPUT at several Far East Russian ports; and monitoring the activities and background radiation levels of the submarine naval base at Petropavlosk. Civil - military relations have dipped to new lows based on a lack of trust and confidence generated by the military's evasiveness on radioactive waste management questions. Russian "Greens" have nicknamed this phenomena "radiophobia", and it is of growing concern to regional military commanders.<sup>90</sup>

There are some signs that the environment has risen a lot higher on the Russian agenda. Perhaps the greatest indication of an environmental awakening within the Russian Federation is the

publication of the Yablokov report, which is as unflattering an expose' of national environmental activity as you would ever expect to find. Yet lack of aggressive corrective action on the FSU's environmental legacy could lead to further instability in an already turbulent Russian Federation.

Third, reduction of the environmental danger to the global marine environment, the "global commons", is a recurring U.S. interest. The United States has played an active role in ocean conservation programs for several decades; taking on such programs as protecting whales, sponsoring moratoriums on driftnet fishing, and minimizing the impact of tuna and shrimp fishing on the populations of dolphins and sea turtles.<sup>91</sup> The United States has been a leading proponent of the London Dumping Convention, including support for the total ban on radioactive waste dumping in November 1993. Allowing a major actor in the international community to blatantly disregard several treaty obligations, and mislead international agencies on the nature of radioactive waste management can only be viewed as destabilizing to the effectiveness of international institutions, as well as bringing further harm to the environment. It is not in the U.S. interest to allow the FSU legacy to continue.<sup>92</sup>

#### **RECOMMENDED POLICY INITIATIVES TO SATISFY U.S. INTERESTS**

The policies required to satisfy U.S. objectives of survival, attaining regional stability, and reducing the environmental danger of Russian radioactive waste dumping include bilateral arrangements, regional multi-national cooperative efforts, mediation by international organizations, and legal remedies. There is much that the United States can do both unilaterally and collectively to assure its own interests. But it is important to recognize that the principal beneficiary of improved environmental action in the Northern, Baltic, and Far Eastern Seas; and the country who bears both the responsibility and obligation to correct past illegal environmental activities, is the Russian Federation. This mandates a commitment on the part of the Russian Federation to complete the disclosure of past dumping activities, allow international activities full access to dumping sites, and reallocate policy and budget priorities, to expend more than 0.5 per cent of its annual budget to environmental protection and clean-up.<sup>93</sup> In all actions the U.S. pursues, it is vital

that Russian cooperation be a precursor to resource allocation, and joint action.

## **SURVIVAL INITIATIVES**

Monitoring mechanisms to ensure the Alaskan marine food chain is not contaminated by transported radionuclides, and thereby risking the health of U.S. citizens, requires greater data on the Arctic sediment, water chemistry, current circulation patterns, and the food chain. The data requirement is being addressed by U.S., U.N., and regional researchers in a variety of ways. In the United States, the Office of Naval Research is continuing its Public Law 102-396 Research Project: Nuclear Pollution in Arctic Seas. Amongst the ONR targeted data collection effort are riverine inputs of radionuclides and transport by ice, estimates of radionuclide disposition over time, environmental factors for radiation transport, and dump site/source strength characterization. These all lead to the development of a predictive model of radionuclide dispersal in the Arctic Ocean. Concurrent analysis using the Polar Ice Prediction System will address possible paths taken by nuclear waste material.<sup>94</sup> Additionally, the National Science Foundation has funded a conceptual and preliminary design for a dedicated Arctic Research vessel; construction is anticipated to commence in 1994, with Initial Operating Capability (IOC) in 1996.<sup>95</sup> This dedicated asset will facilitate long term ecological monitoring and basic Arctic research.

The IAEA has initiated the International Arctic Seas Assessment Project (IASAP), which will develop radiation source terms at each of the dumping sites, for inclusion into an Arctic model predicting release rates from waste containers. Data will also be entered into the IAEA's global data base "Inventory of Radionuclides in World Oceans", which will then be shared by scientists of all nations and focus technology initiatives.<sup>96</sup> Also, the Arctic Environmental Protection Strategy ("Finnish Initiative") has chartered the Arctic Monitoring and Assessment Program (AMAP) to place sophisticated monitoring mechanisms at the FSU/Russian dump sites for early detection and warning.<sup>97</sup>

In addressing the Russian military and civilian nuclear reactor operational safety issue, the United States has funded \$125 million in FY 94 Russian Aid for nuclear reactor safety and environmental technical assistance. The Department of Energy and the Nuclear Regulatory

Commission are establishing a Russian reactor safety training center with these funds.<sup>98</sup> The United States has additionally pledged \$400 million in "Nunn-Lugar" assistance to Russia, to include \$10 million to assist in safe nuclear weapon and reactor dismantlement.<sup>99</sup> Further assistance is forthcoming in the new foreign aid packages of Canada, Germany, Britain, Finland, and Japan.<sup>100</sup> Japan, in particular has pledged \$100 million for the construction of a radioactive waste disposal facility.

Another assistance program underway involves a World Bank, USAID, and U.S. Environmental Protection Agency (EPA) team who are preparing a \$3-4 million environment/energy loan package designed to attract non-governmental organization (NGO) funding for Russian environmental clean-up.<sup>101</sup> A lucrative and inexpensive area of assistance to the Russian Northern and Pacific Submarine Force yet to be explored, could come from technical assistance provided by U.S. Navy nuclear trained officers. Discussions on plant safety, lay-up techniques, and nuclear submarine decommissioning lessons learned could go far to reduce the possibility of another Chazma Bay accident.<sup>102</sup>

## **REGIONAL STABILITY INITIATIVES**

Continued United States support for the ongoing cooperative multi-national efforts will yield huge dividends in addressing the regional stability threat posed by Russian radioactive waste dumping. In the Arctic region, the United States through the National Academy of Sciences, should remain active with the International Arctic Science Committee (IASC), which is committed to international consultation and cooperation for Arctic scientific research.<sup>103</sup> Additionally, the Arctic Monitoring and Assessment Program, which is the implementing arm of the Arctic Environmental Protection Strategy (AEPS) adopted by the Arctic States in 1991<sup>104</sup> must continue to receive personnel and resources from the EPA and National Oceanographic Atmospheric Administration (NOAA).

In the Baltics, the United States should remain firm in its commitment to Latvia and Estonia's efforts to resettle Russian Federation troops from their soil. This is best achieved through close monitoring of the execution of the State Department's FY 93 Officer Resettlement



Initiative, which provides Russian officers with housing, employment retraining, and resettlement costs (roughly \$6 million).<sup>105</sup> Following Russian troop withdrawal, the United States should offer, in concert with the Helsinki Commission (HELCOM), to mediate the Estonian's compensation claim against the Russian Federation for the Silamae nuclear waste dump clean up. Additionally, the United States should provide technical assistance to the Baltic Sea Joint Comprehensive Environmental Action Programme, in the form of applied research, environmental awareness training, and promotion of private investment through commerce concessions and incentives.<sup>106</sup> HELCOM's program may be the benchmark for follow-on action in the Arctic and Sea of Japan.

In the Far East, the United States must remain in lock step with the Japanese in support of zero nuclear waste disposal in the Sea of Japan. Encouragement (and assistance if required) for rapid implementation of the Japanese decision to build a radioactive waste disposal facility in the Russian Far East should be on top of the U.S.- Japan agenda. U.S. theatre intelligence assets could also be used to assist in monitoring Russian compliance with her bilateral and multilateral agreements not to dispose of nuclear wastes at sea.

#### **INITIATIVES TO ADDRESS THE REDUCTION OF ENVIRONMENTAL DANGER TO THE MARINE ENVIRONMENT**

Several proposals show promise of ameliorating the dangers to the marine environment caused by Russian radioactive waste dumping. First, while planning and construction of the Japanese funded radioactive waste disposal facility is ongoing, provision of surplus oil tankers and large cargo capacity shipping could be provided to the Russian's for temporary storage of liquid nuclear wastes. This State Department initiative would be a stop-gap measure, designed principally to buy time for longer term solutions and provide the Russians with some additional flexibility.

Second, the Russians need to be convinced that it is in both their short and long term interest to temporarily store all produced nuclear waste at a land based site, until permanent facilities can be constructed. This can be achieved by linking payment on specific elements of U.S. aid (subsets of Nunn-Lugar funds), international aid, and World Bank funds to a systematic,

regularized Russian mechanism for transfer of nuclear wastes to a land site or sites, and cessation of ocean dumping.

Third, use of the Philadelphia Naval Shipyard as a dismantlement site for Russian Navy ships, including nuclear submarines, has been proposed by Representative Curt Weldon (R, Pa), Senator Arlen Specter (R, Pa), Mr. Gary Sojka (U.S. Senate Intelligence Committee), and Mr. Boris Ivanof (Russian Federation Foreign Ministry).<sup>107</sup> The advantages of this embryonic program include: jobs for U.S. skilled workers; keeping Philadelphia Naval Shipyard open; scrapping of obsolete and unsafe vessels in exchange for hard currency to the Russians; removing potential radioactive waste dump candidates from the disposal pool; and business opportunities and profits for American businessmen. "American officials said...the plan's success would hinge on developing a procedure that is environmentally sound and consistent with existing environmental regulations, and putting together a profitable business plan."<sup>108</sup> If feasible, every participant in this scheme gets a "win".

Finally, liability provisions in the London Dumping Convention, UNCLOS III, and the Helsinki Convention 1992 need to be strengthened in order to provide binding and enforceable law which makes radioactive waste dumping at sea prohibitively expensive to the Russian Federation, and other violators. Use UNCLOS III's International Tribunal for the Law of the Sea as the judicial forum to prosecute violations; and create a hierarchy of punishments: fines, sanctions, withdrawal of World Bank/International Monetary funds, and loss of voting privileges in the U.N. General Assembly and Security Council as the means of last resort. Coercion needs to be installed to make our international institutions and international treaty obligations effective in achieving cessation of radioactive waste dumping

## **CONCLUSION**

Irresponsible nuclear waste management by the Former Soviet Union has created an environmental legacy that will significantly challenge the Russian Federation's resources, technical skills, international diplomacy, and political leadership. This legacy also poses an ominous ecological threat to the countries bordering the Northern, Baltic, and Far East Seas. The Russians

can choose to write off the past, sigh about the sins of the Bolsheviks, and conduct their nuclear power program "like we've always done it". Conversely, they can accept their obligations, allow international access to their dumping sites, and find land based alternatives for nuclear waste management. The first choice involves increasing isolation, a raising of regional tensions, and high risk of irreparable harm to Russian citizens, property, and ecology. The second choice demonstrates commitment to international stability, a sincere desire to operate as a responsible nation state, and a willingness to seek solutions to a hard environmental problem which can be solved cooperatively. The Russians have not yet made their final choice; but the material condition of their collective nuclear power system requires them to do so quickly.

For the United States, it is imperative that mechanisms be put in place to keep environmentally hazardous nuclear wastes isolated from American lives, property, and industry. Regional multi-national cooperative efforts, and comprehensive enforceable international law are the best ways of combatting this environmental security threat. Both the danger of an urgent catastrophic failure to a Russian nuclear power plant, with release of sizable quantities of radioactivity beyond its borders; and the risk of chronic long term radioactive build-up, with attendant impact on marine species survivability, bio-diversity, and economic hardship must be included in the calculus of policy response. Satisfaction of our national interests: survival, promoting regional stability, and reduction of environmental danger can be achieved, and in so doing, we can also bring the Russian Federation much closer to becoming a true democratic state.

## ENDNOTES

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- <sup>7</sup> Tomas Ries, 398.
- <sup>8</sup> Joshua Handler, "The Northern Fleet's Nuclear Submarine Bases", Jane's Intelligence Review, Volume 5, No. 12, December 1993: 551-556.
- <sup>9</sup> D.J. Bradley, Radioactive Contamination of the Arctic Region, Baltic Sea, and the Sea of Japan From Activities in the Former Soviet Union, Richland, Pacific Northwest Laboratory, 1992: 2.
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- <sup>14</sup> Tomas Ries, "Russian Nuclear Reactors in the Nordic Region", Jane's Intelligence Review, Volume 5, No. 8, August 1993: 364.
- <sup>15</sup> D.J. Bradley, Radioactive Contamination of the Arctic Region, Baltic Sea, and the Sea of Japan From Activities in the Former Soviet Union, Richland, Pacific Northwest Laboratory, 1992: 10-11.
- <sup>16</sup> Tomas Ries, "Russian Nuclear Reactors in the Nordic Region", Jane's Intelligence Review, Volume 5, No. 8, August, 1993: 362.
- <sup>17</sup> Janusz Kindler, and Stephen F. Lintner, "An Action Plan to Clean Up the Baltic", Environment, Volume 35, No. 8, October 1993: 7.
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